Space Weather Technical Forecast

Issued on Monday, 13 December 2021 at 13:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/Minor Geomagnetic Storms, mainly day 3 (15th)

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar Activity was Low, with one C1 flare observed at 12/2114 UTC from the new sunspot region that recently rotated onto the Earth-facing disc from around the southeast limb. Two further sunspot containing active regions remain on the Earth-facing disc. Both remain small and simple. AR2905 Cro/Beta in the southeast and a new unnumbered region Bxo/Beta in the northeast, though this region appears to be decaying to plage. No Earth-directed CMEs have been observed in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind speed, as measured by DSCOVR and ACE at L1, was at background levels throughout, with a gradual increase from around 290km/s to between 320-340km/s by the end of the period. Density was around average until 12/1700 UTC before gradually increasing to be mainly above average at around 20ppcc, though with a couple of periods of average density since 13/0200 UTC. The Interplanetary Magnetic Field strength (IMF), Bt, was mainly weak, but two intervals of moderate IMF were recorded since 13/0300 UTC, peaking at just under 10nT. The Bz component was variable ranging from -7 nT to +6 nT. Phi angle was initially negative (towards the Sun) for much of the period, but rotated to a mainly positive (away from the sun) sector between 12/2000 and 13/0800 UTC. Geomagnetic activity was mostly Quiet (Kp 0-2), with one Unsettled (Kp3) interval between 13/0300-0600 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels. The high energy electron flux (greater than 2 MeV) was at generally Moderate levels initially, but then became mainly Background levels from 12/2200 UTC. The associated 24-hour integrated fluence persisted below the Active threshold, with 1.31e7 observed at 12/2100 UTC

Four-Day Space Weather Forecast Summary

Solar Activity: Solar Activity is expected to be Low to Very Low, with a 60% chance of further C-class flares from any of the emergent sunspot regions on the disc.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs expected in the forecast period. Background solar wind speeds could become slightly elevated to elevated day 1 (13th) from the arrival of fast wind from newly developed CH34, however confidence is low. A subsequent connection to CH32 fast wind is then expected to give elevated solar winds either late day 2 (14th) or more likely on day 3 (15th), before slowly easing back day 4 (16th). Quiet geomagnetic conditions at first will likely become Unsettled to Active for a period day 1 (13th), and then again but more persistently later day 2 or more likely day 3, also with an increased chance of isolated G1/Minor Storms intervals. This risk probably decreasing by day 4, with geomagnetic activity gradually decreasing to Quiet with Unsettled intervals.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels. The high energy electron flux (greater than 2 MeV) is

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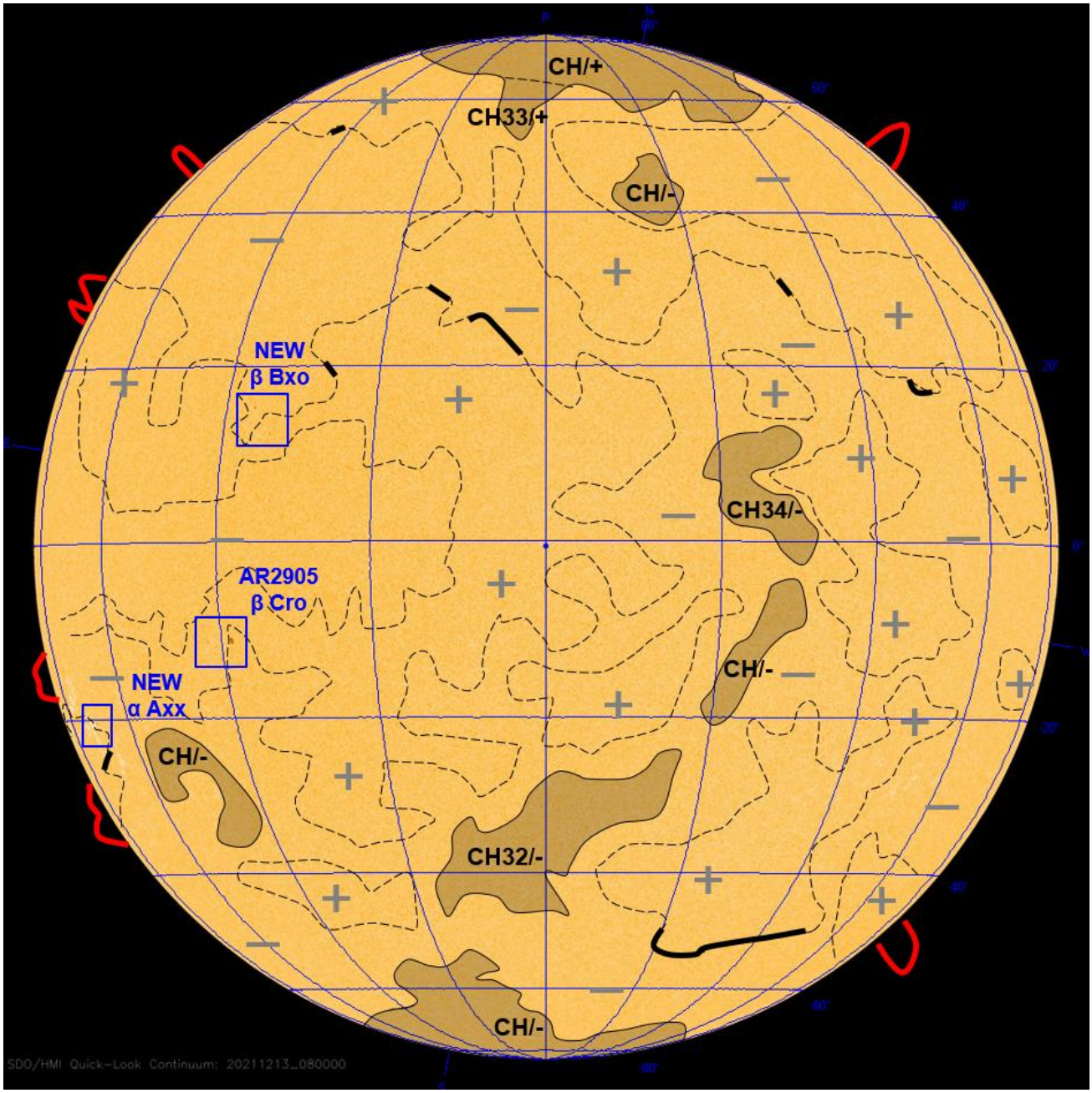
expected to be Background to Moderate levels initially. The arrival of the fast winds of CH34, day 1 (13th), and then CH32, most likely late day 2 (14th) or day 3 (15th), has the potential to increase the flux with persistently High flux possible by day 4 (16th), although confidence remains Low for this. The associated 24 hour fluence is expected to persist below the Active level day 1 and day 2, but with an increasing chance of rising above by the end of day 4.

Figure 1. Solar Analysis Valid 13/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs expected during the forecast period. Solar winds are currently at background, but continuing to exhibit above average density. This is potentially due to heliospheric current sheet interactions ahead of a fast wind of a newly opened coronal hole, CH34/-, in the western hemisphere. STEREO A PLASTIC data, indicates a slight enhancement was observed for the equivalent day, and any subsequent fast wind has likely strengthened as this hole as opened. Consequently slightly elevated to elevated winds are likely day 1 (13th) or day 2 (14th), 450-500km/s.

This is expected to be followed by a gradual transition into the persistent CH32/- in the southern hemisphere near the centre disc. On the previous rotation this brought L1 speeds of 600 km/s, and lead to a G1/Minor Storm interval. Despite some eastward retreat resulting in a later connection that persistence would suggest, a similar observed speed at L1 is possible late day 2 (14th) but more probable on day 3 (15th). Solar winds are then likely to gradually ease during day 4 (16th).

A lack of STEREO A PLASTIC data since late on the 11th means that confidence in timings and strength of these features are low.

Quiet geomagnetic conditions at first will likely become Unsettled to Active for a period day 1, and then again but more persistently later day 2 or more likely day 3, also with an increased chance of isolated G1/Minor Storms intervals. This risk probably decreasing by day 4, with geomagnetic activity gradually decreasing to Quiet with Unsettled intervals.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	30	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections - Nil

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Radio Blackouts - X-Ray Flares:

Solar Activity is currently at Low levels, with a C1-flare observed from a newly visible sunspot region on the southeast limb. This is still too close to the limb and foreshortened in coronagraph imagery to allow for a confident assessment. The given configuration at the previous Sunspot Region Summary was Axx/Alpha, however, there is recent evidence to suggest that this is a Bxo/Beta group.

Two further sunspot containing active regions remain on the Earth-facing disc; both are small and simple. AR2905 Cro/Beta is located in the southeast and a new unnumbered region Bxo/Beta in the northeast, though the latter appears to be decaying to plage.

A new region of bright flux appears to be rotating over the eastern limb presently to the east of the new sunspot region in the southern hemisphere. Unfortunately there is no recent EUVI STEREO A imagery to corroborate this, though SDO coronagraph imagery seems to suggest, at least, the presence of an area of plage.

Solar Activity is expected to continue at Low to Very Low levels, with a 60% chance of further C-class flares each day. The chance of increasing to Moderate is currently very low, but slightly increased above background (2%) given the new regions close to the eastern limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	2	2	2	2
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 is forecast to remain at background levels.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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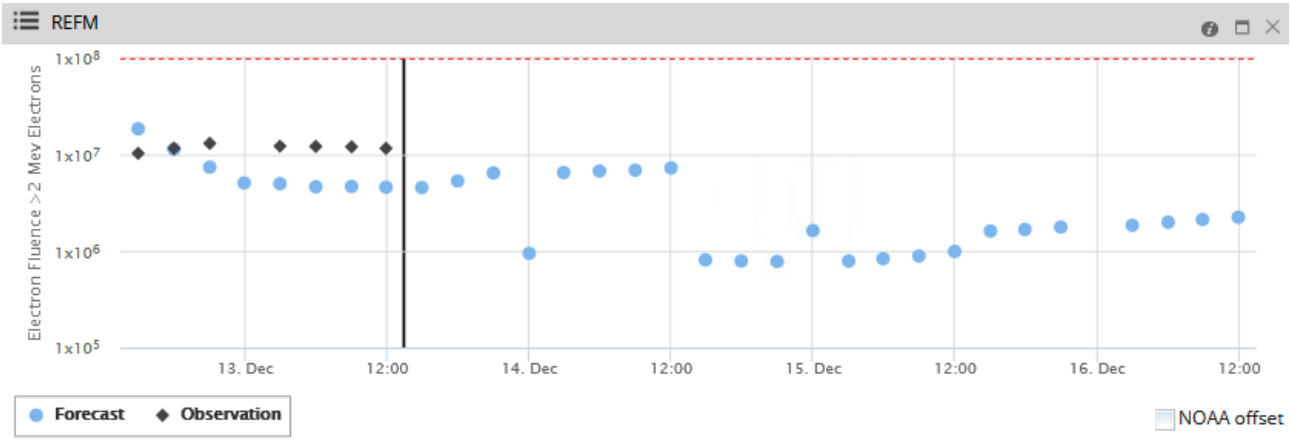
High Energy Electrons Event (≥ 2MeV):

The high energy (greater than 2 MeV) electron flux, as observed by GOES-16, is expected to be Background to Moderate levels initially. The arrival of the fast winds of CH34, day 1 (13th), and then CH32, most likely late day 2 (14th) or day 3 (15th), has the potential to increase the flux with persistently High flux possible by day 4 (16th), although confidence remains Low for this.

The associated 24 hour fluence is expected to persist below the Active level day 1 and day 2, but with an increasing chance of rising above by the end of day 4. This is supported by REFM which maintains fluence below the Active threshold.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 2: Latest MOSWOC REFM output.



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